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Accelerator Division  
Technical Note

No. 230

PREINJECTOR DOUBLET

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Introduction

In order to reduce preinjector down time, a conventional pulsed quadrupole doublet has been designed and constructed as a replacement for the septier quadrupoles used in both Linac preinjectors. These new quadrupoles have proven to be extremely reliable because of their simple mechanical construction and low operating power requirements. In addition, a much higher quality field has been obtained with the new quadrupoles.

Quadrupole Parameters

A comparison of operating parameters is as follows:

	<u>Septier Quads</u>	<u>New Quads</u>
Operating Current (Pulsed)	200 Amps	40 Amps
Resistance	0.155 Ohms	0.130 Ohms
Operating Voltage	40 V	60 V
Inductance	1.5 mh	2.5 mh
Power	6,200 W x D cycle	210 W x D cycle
Gradient at Operating Current	400 G/cm	400 G/cm

(duty cycle is equal for both quads)

### Construction

Quadrupole coils were constructed of 0.100" diameter copper wire with 0.002" thick Kapton insulation. The total number of turns required for one quadrupole was 140 (35 turns per pole). In order to avoid building expensive coil winding fixtures, coils were wound as shown on Figure 4, in the upward direction only. Plastic inserts equal to the thickness of the coil wire were used to eliminate uneven coil sides introduced by wire cross-overs from top to bottom. One cross-over on each side of the coil was required. Each coil was epoxy impregnated and lashed with 1" wide glass cloth.

Figure 1 illustrates construction of the quadrupole iron. The magnet yoke and pole tips were machined from epoxy painted 0.031" thick, 7" square laminations backed by two 0.100" thick low carbon steel plates and held together with 3/16 diameter x 2-3/4 long stainless steel rods and #6-32 ft. hd. screws. In all, 83 laminations were used with nominal 0.002" thick epoxy layer between them. Pole tips were machined from the plug cut out from stacked laminations as shown on Figure 1. Pole tip dimensions and their shape are shown on Figure 2. Assembly of back iron and pole tips is illustrated on Figure 3.

### Magnet Design and Measurements

The pole profile for these magnets has been adapted from the LESB II 12Q12 quadrupoles and from Brookhaven "narrow quadrupole" studies.<sup>1</sup> The coil slot dimension has been chosen such that the integral effect of the first harmonic of the quadrupole ( $6\theta/2\theta$ ) is essentially zero. Field harmonics have been measured at 75% of the pole tip radius and are  $< 0.1\%$  except for the  $10\theta/2\theta$  term which is 0.6% and agrees with the scaling prediction.

### Conclusion

Initial tests indicate some increased Linac performance. A program of emittance measurements is being initiated in order to quantify this effect.

### Acknowledgments

We wish to thank G. Danby, E. Jablonski, A. McNerney, and R. Horton for advice and support. Special thanks go to W. Shaffer of the Linac Group for valuable ideas and skilled efforts in the construction of the prototype quadrupole. We also wish to thank B. Briscoe and J. Weisenbloom for testing the quadrupoles.

### Reference

1. G.T. Danby and J.W. Jackson. Theory, design and measurement of the Brookhaven narrow quadrupoles. Proc. 1967 National Particle Accelerator Conf., March, 1967.

.100 THK.  
BACKING  
PLATES

MAGNET YOKE

PLUG TO BE CUT OUT  
& USED FOR MANUFACTURING OF  
POLE TIPS. (SEE FIG. 2)

7" SQ.

83 LAMINATIONS

$2\frac{15}{16}$

MAT'L

- 1) BACKING PLATES -  
1006/1010 LOW CARBON ST.
- 2) ELECTRICAL GRADE STEEL (M-36)  
.031" THK. (AGS SPEC #2)

$\frac{3}{16}$  DIA. ST. STEEL RODS

FIG. 1

LAMINATIONS STACKED WITH EPOXY

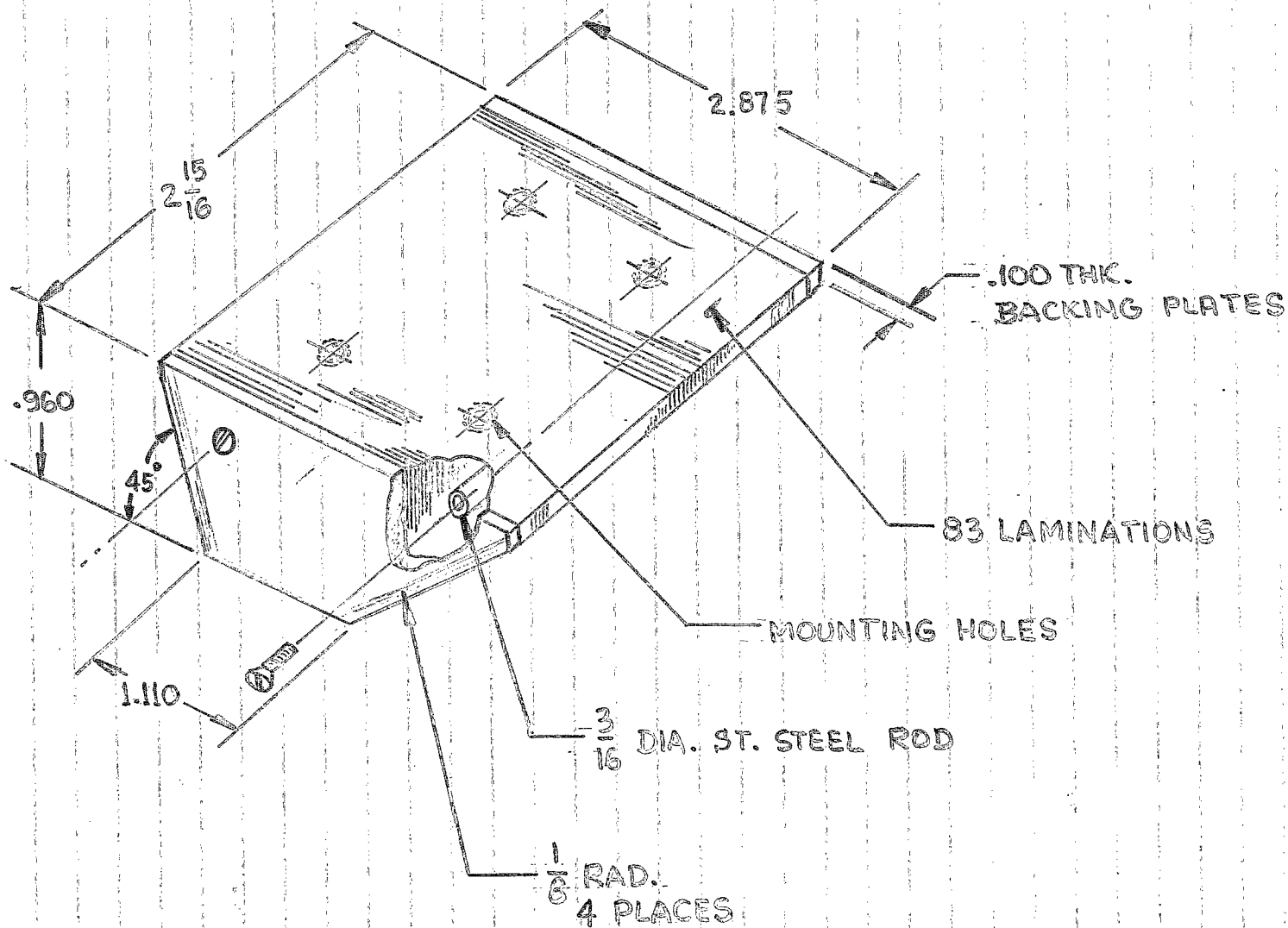


FIG. 2  
POLE TIP

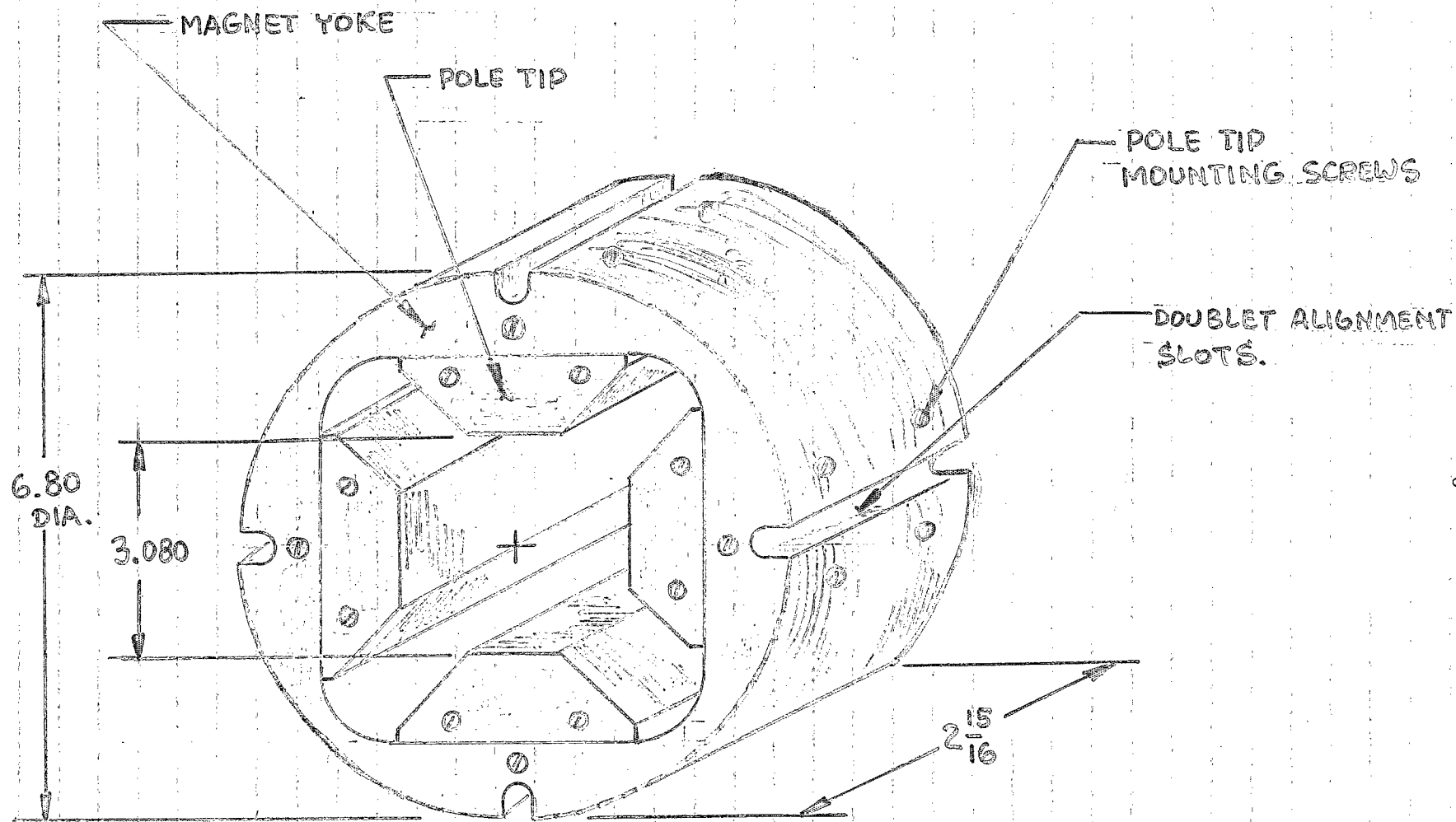
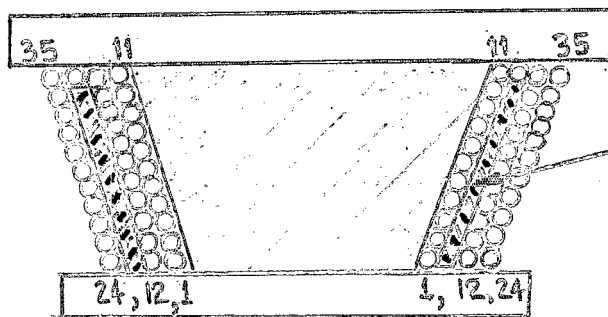


FIG. 3  
MAGNET IRON ASS'Y



SECTION "X-X"

# COIL WINDING FIXTURE

-G-10 SPACES  
ONE SET ON BOTH  
SIDES OF COIL.

3  $\frac{3}{4}$  COIL  
LENGTH

TOP

**BOTTOM**

COIL WIRE  
(.100 O.D. COPPER)  
WITH 2 MILS THK.  
CAPTON INSULATION.

- EACH CONSECUTIVE  
LAYER OF COIL  
STARTS AT THE BOTTOM  
OF WINDING FIXTURE.  
(SEE SECTION "X-X")

FIG. 4

# COIL & COIL WINDING FIXTURE

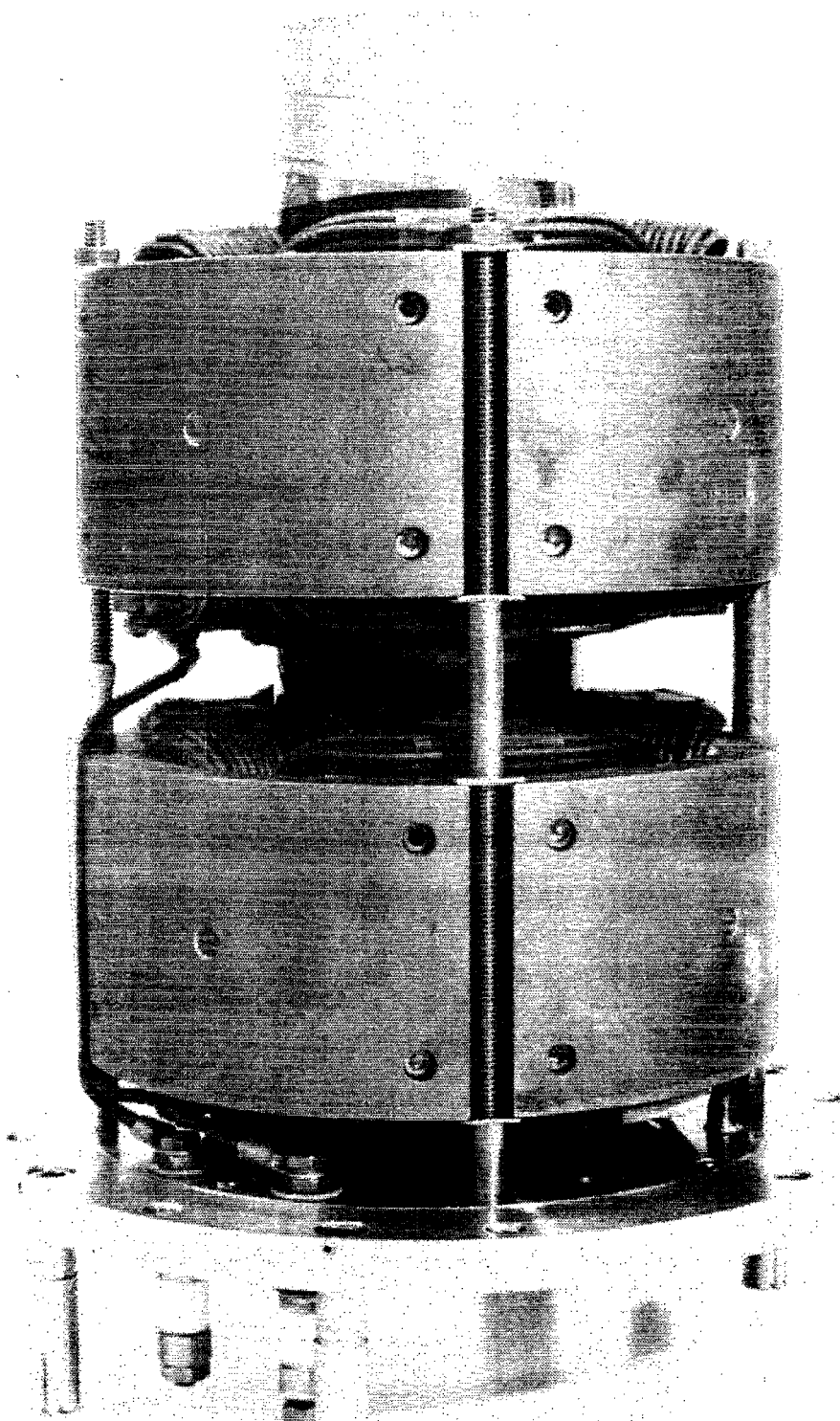


FIG. 5

MAIN ASSEMBLY